

The Pelvic Girdle and Hip Joint

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Objectives

After studying this topic, the students will be able to:

1. Identify the structures of the pelvis and hips, including joint type, articular shape, and the surrounding tissues.
2. Describe joint motions occurring at the pelvis and hip, including movements, muscle actions, and factors affecting joint motions and stability.
3. Understand the stability mechanism of the pelvis and hip and the possible mechanisms of injury.
4. Identify the malalignment of the weight bearing joints.

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Functions of the pelvic girdle and hip joint

Functions of the pelvis are:

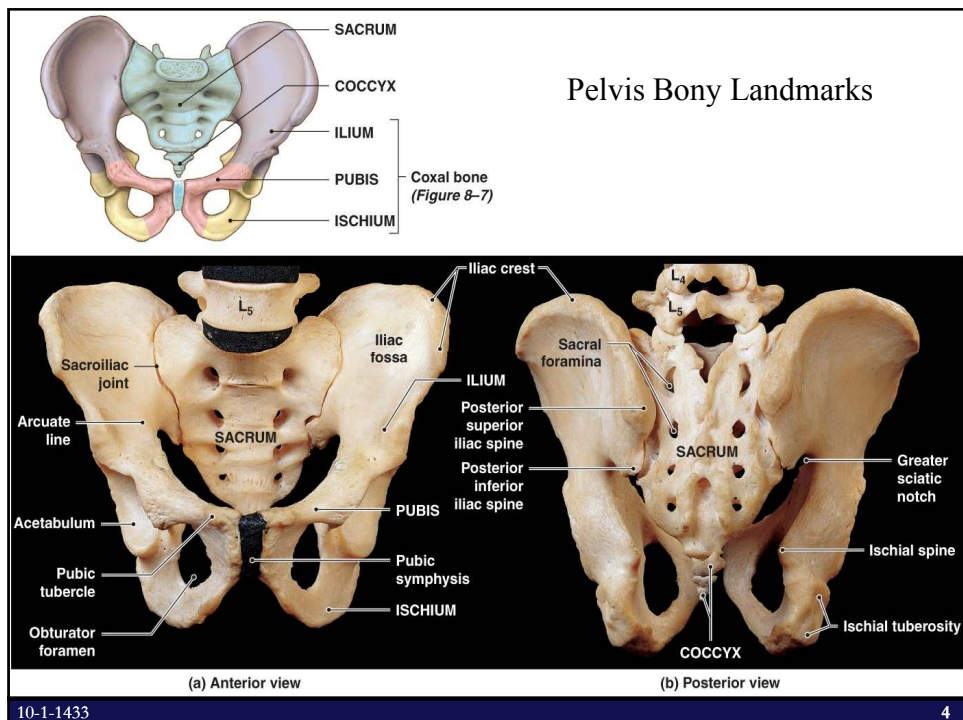
- To link the lower extremity with the trunk.
- To transmit the load of the trunk to the lower extremity.
- To absorb the shock from the ground.
- To protect the internal organ.

Functions of the Hips are:

- To provide stability for weight bearing activities, such as standing, walking, or running.
- To allow mobility of the leg in space.
- To transmit the loads from the upper body to the thigh and then to the lower leg.

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Anatomical Structures of the pelvic and Hip (Bones)

- **Pelvic girdle**

- right & left pelvic bone joined together posteriorly by sacrum
- pelvic bones are ilium, ischium, & pubis

- **Sacrum**

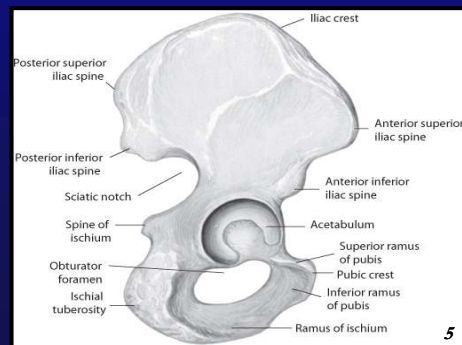
- extension of spinal column with 5 fused vertebrae
- extending inferiorly is the coccyx

Pelvic bone - divided into 3 areas:

Upper two fifths = ilium

Posterior & lower two fifths = ischium

Anterior & lower one fifth = pubis



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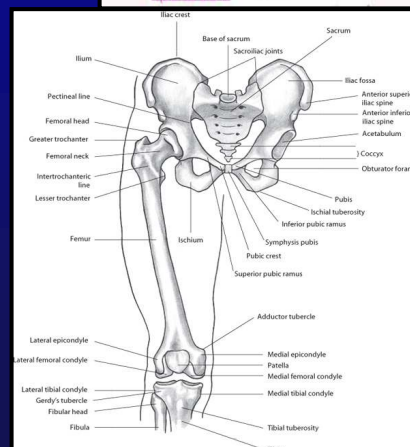
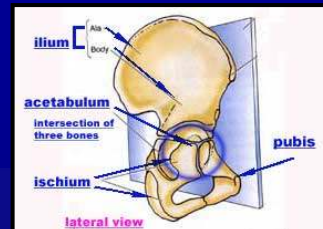
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Anatomical Structures of the pelvic and Hip (Bones)

- **Head of femur connecting with acetabulum of pelvic girdle to form ball & socket joint**

- **Femur**

- longest bone in body



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Bony landmarks for pelvis and hip

- Anterior pelvis - origin for hip flexors
 - Iliac crest (tensor fasciae latae)
 - Anterior superior iliac spine (sartorius)
 - Anterior inferior iliac spine (rectus femoris)
- Lateral pelvis - origin for hip abductors
 - Below iliac crest (gluteus medius & minimus)
- Medially - origin for hip adductors
 - pubis & its inferior ramus (adductor magnus, adductor longus, adductor brevis, pectineus, & gracilis)
- Posteriorly – origin for hip extensors
 - Posterior iliac crest & posterior sacrum & coccyx (gluteus maximus)
- Posteroinferiorly - origin for hip extensors
 - Ischial tuberosity (hamstrings)
- Proximal thigh - insertion for short muscles of hip
 - Greater trochanter (gluteal muscles & most of the six deep external rotators)
 - Lesser trochanter (iliopsoas)

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Bony landmarks for knee

- Proximal thigh - origin for 3 knee extensors
 - Patella – insertion for all 4 quadriceps muscles
 - linea aspera (hip adductors)
- Proximal tibia or fibula – insertion for remainder of hip muscles
 - biceps femoris, iliotibial tract of tensor fasciae latae, sartorius, gracilis, semitendinosus, & semimembranosus

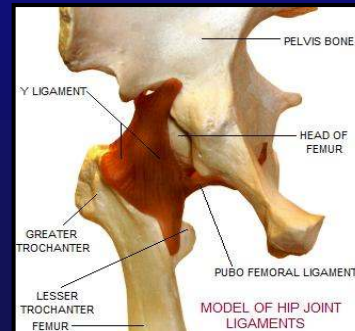


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Pelvis and hip Joints

- Large & heavy bones covered by thick, heavy muscles
- Very minimal oscillating-type movements occur in sacroiliac joints, as in walking
- Body movements usually involve entire pelvic girdle & hip joints
- In walking, hip flexion & extension occur with pelvic girdle rotation, forward in hip flexion & backward in hip extension



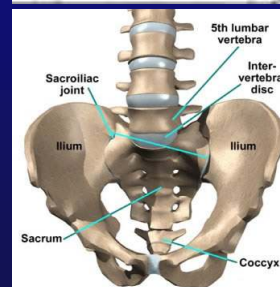
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Joint Structure of the Pelvis

Joints at Pelvis are:

- **Anteriorly: pubis symphysis (pubic joint)**
 - Two pelvic bones join to form symphysis pubis, amphiarthrodial.
- **Posteriorly: sacroiliac joint (SI joint)**
 - Sacrum is between the 2 pelvic bones & forms the sacroiliac joints
 - Strong ligaments unite these bones to form rigid, slightly movable joints.

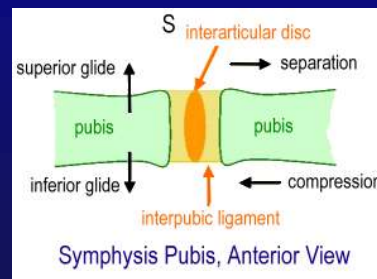
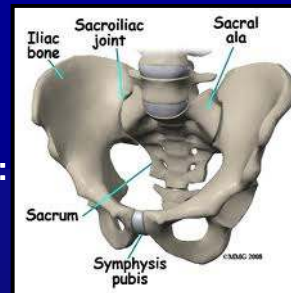


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Pubic Symphysis (Pubic Joint)

- **Amphiarthrosis (fibrocartilage joint):**
 - Articular surfaces covered with hyaline cartilage and held together by an interpubic disc and ligaments
- **joint type**
 - Secondary cartilaginous joint
- **Motion:**
 - superior/ inferior glide
 - separation/ compression
- **Functions:**
 - shock absorption during walking and for woman's baby delivery

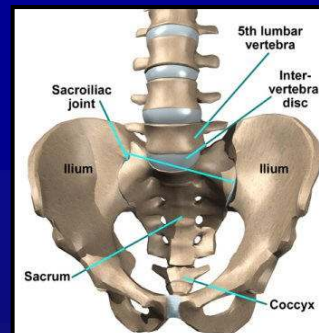


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Sacroiliac (SI) joints

- **Proximal component: sacrum**
 - irregular articular surface
- **Distal component ilium**
 - irregular auricular surface of the ilium
- **joint type:**
 - Synovial diarthroidal joint
- **Motion:**
 - Up-and-down gliding &
 - Anterior-posterior movement of sacrum on the ilia or the ilia on the fixed sacrum
- **no muscles cross over this joint**

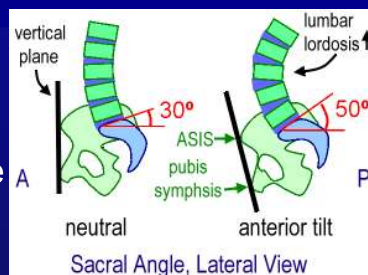


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Sacral Angle

- The angle of the superior margin of the sacrum from the horizontal plane
- Healthy adults: $\sim 30^\circ$
- Neutral position of the pelvis: the plane where both anterior superior iliac spines (ASIS) and the pubis symphysis are located is parallel to the frontal plane
- Lumbar lordosis increased if the pelvis is anteriorly tilted and so the sacral angle will increase.

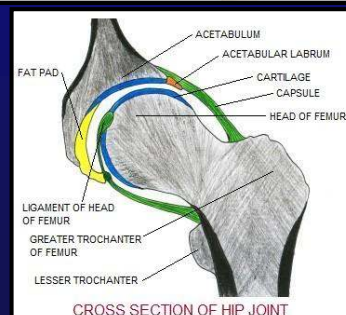
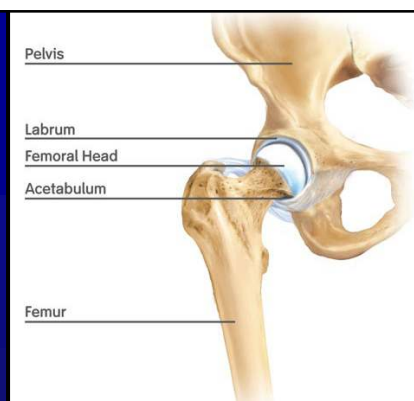


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Anatomical Structures of the Hip

- Acetabulum
- Acetabular labrum
- Articular cartilage
- Femoral head
- Joint capsule
- Ligaments
- Hip musculature



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Acetabulum

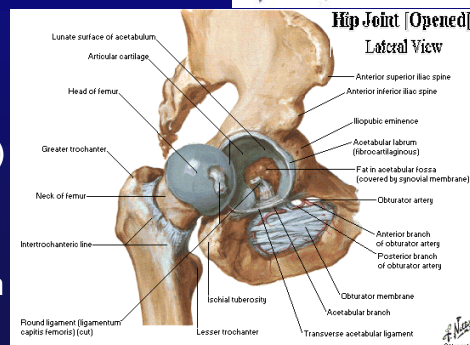
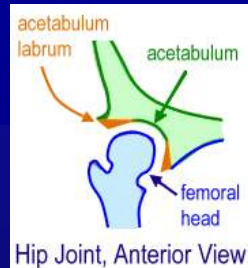
- Cup-shaped bony structure formed by part of the ilium, ischium, and pubis.
 - ❑ acetabular notch: incomplete bony rim in the inferior pole, covered with transverse acetabular ligament.
 - ❑ lunate surface: only the periphery of superior, anterior, and posterior articular surfaces are in contact with the femoral head.
- Cartilage thicker peripherally and acetabulum labrum deepen the shape
- Diameter changes with loading
 - ❑ unloaded condition: Acetabulum articular surface has a smaller diameter than that the femoral head.
 - ❑ loaded condition: Acetabulum cartilage deforms to become congruent with the femoral head.

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Hip (Acetabulofemoral) joint

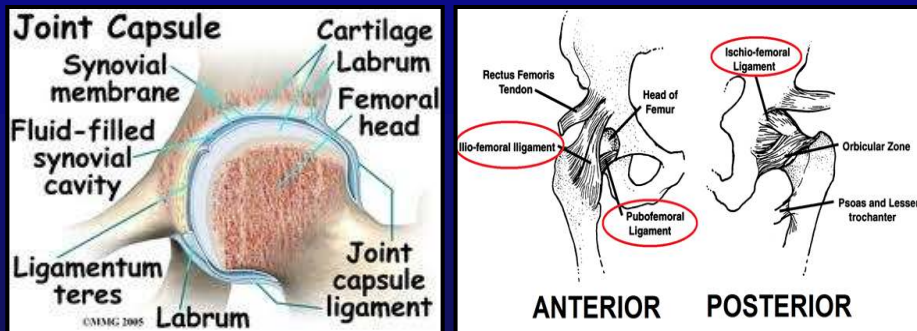
- **Proximal component:** pelvis
 - concave acetabulum that faces anterior, inferior, and lateral
- **Distal component:** femur
 - convex femoral head that faces anterior, superior, and medial (anteversion)
- **Joint type**
 - ball-and-socket joint
- **Motion:** (convex on concave)
 - hip flexion/ extension
 - hip abduction/ adduction
 - hip external/ internal rotation
- **DOF = 3**



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Hip Joint Capsule & Ligaments

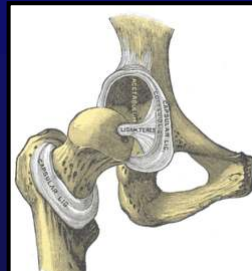
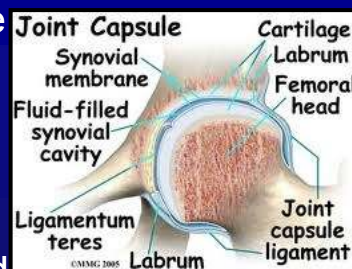


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Hip Labrum and Articular Cartilage

- **Acetabular labrum** – fibrocartilage extension of acetabulum; adds depth and stability to the joint
- **Articular cartilage** – maximal thicknesses of acetabular and femoral articular cartilage is aligned at their superior-anterior aspects
- Maximal joint reactive forces and pressures seen at the superior-anterior aspect of the acetabulum



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Hip Capsule and Ligaments

- Hip joint capsule reinforced externally with tough capsular ligaments
- Capsule lined internally with synovial membrane
- Ligaments and capsules are secondary joint stabilizers
- Normal capsule and ligaments limit extreme hip ROM; pathological tightness may limit normal functional hip joint ROM

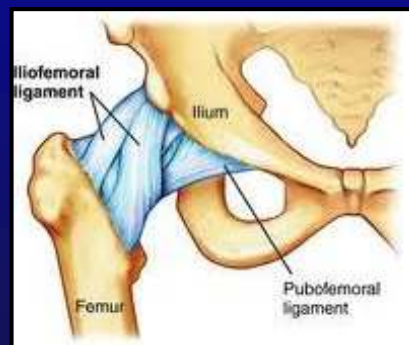


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Hip Capsule and Ligaments (cont.)

- **Iliofemoral ligament** or **Y ligament** – located anteriorly, prevents hyperextension
 - one of the thickest and strongest in the body; can effectively prevent extreme hip extension.
- **Pubofemoral ligament** - located anteromedially & inferiorly, limits excessive extension & abduction

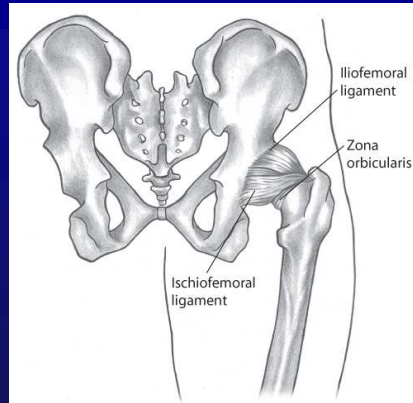


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Ligaments (cont.)

- Teres ligament - is strong ligament attaches from deep in acetabulum to a depression in femoral head, slightly limits adduction
 - Its primary function is to carry the vascular supply to the head of the femur
- Ischiofemoral ligament – located posteriorly, extends from ischium to trochanteric fossa of femur, limits internal rotation



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Closed Pack Position of the Hip

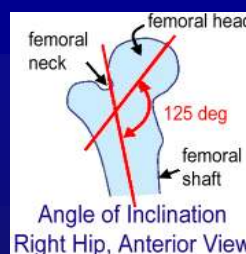
- CPP – unique position of the hip joint where the articular surface is most congruent and the ligaments are maximally taut
- Full passive hip extension coupled with slight internal rotation and abduction maximally stretches the capsule and maintains congruency
- Passive hip flexion coupled with internal rotation and abduction stretches the capsule but is moving away from joint congruency; this is a common pathological “capsular pattern”

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Angle of Inclination (head-neck angle)

- Angle between the longitudinal axis of the femoral neck to that of the femoral shaft in the frontal plane
- Degrees
 - normal adults: 125°
 - Newborn: 140-150°
- frontal plane deformities
 - coxa valga: angle of inclination > 125°
 - coxa vara: angle of inclination < 125°

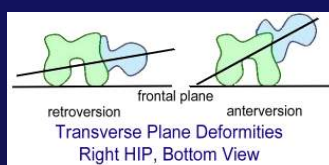
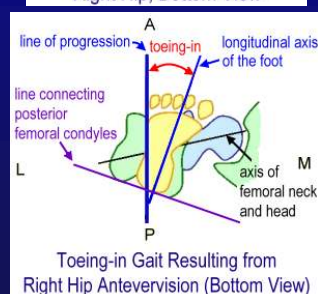
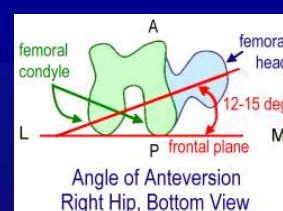


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Angle of Anteversion

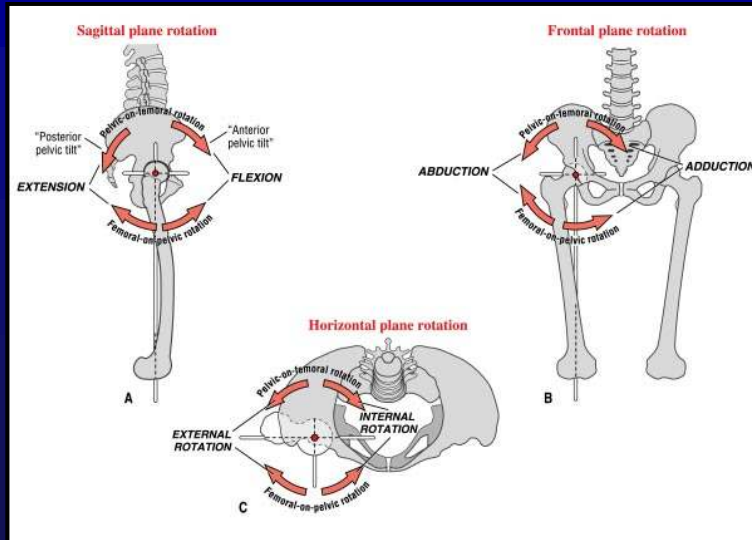
- Angle of the longitudinal axis of the femoral neck to the line connecting posterior aspect of both femoral condyles in the transverse plane
- Degrees
 - normal adults and child > 6 years old: 12-15°
 - Newborn: 30-40°
- Transverse plane deformities
 - Femoral Anteversion: resulting in toeing-in gait
 - Femoral Retroversion: resulting in toeing-out gait



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Osteokinematics of the Hip

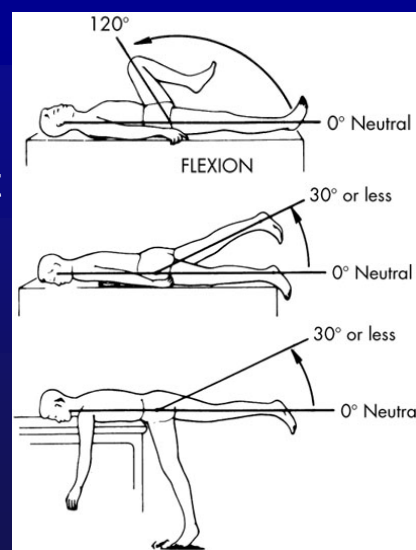


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Hip Joint Kinematics

- Some disagreement about exact possible range of each movement in hip joint
 - 0 to 120-130 degrees of flexion
 - 0 to 30 degrees of extension

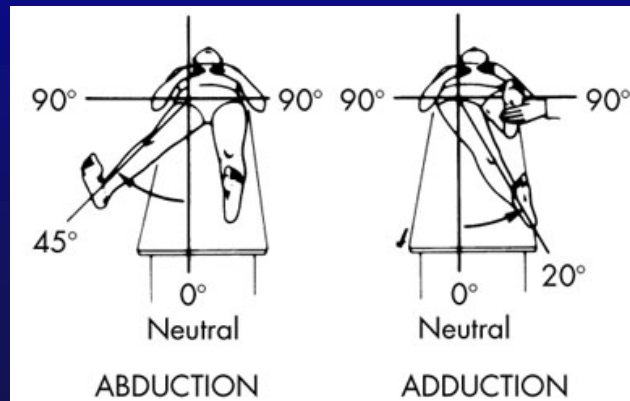


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Hip Joint Kinematics

- 0 to 35-45 degrees of abduction
- 0 to 20-30 degrees of adduction

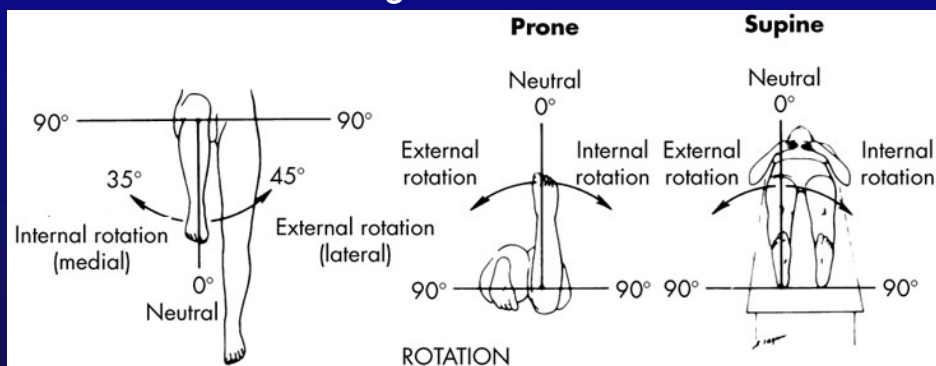


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Hip Joint Kinematics

- 0 to 35-45 degrees of internal rotation
- 0 to 45-50 degrees of external rotation



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Movements of the hip joint

- Hip flexion
 - movement of femur straight anteriorly toward pelvis
- Hip extension
 - movement of the femur straight posteriorly away from the pelvis; sometimes referred to as hyperextension



Flexion
A



Extension
B

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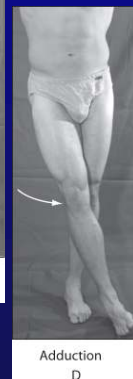
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Movements of the hip joint

- Hip abduction
 - movement of femur laterally to side away from midline
- Hip adduction
 - movement of femur medially toward midline



Abduction
C



Adduction
D

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Movements of the hip joint

- Hip external rotation
 - rotary movement of femur laterally around its longitudinal axis away from midline; lateral rotation
- Hip internal rotation
 - rotary movement of femur medially around its longitudinal axis toward to midline; medial rotation



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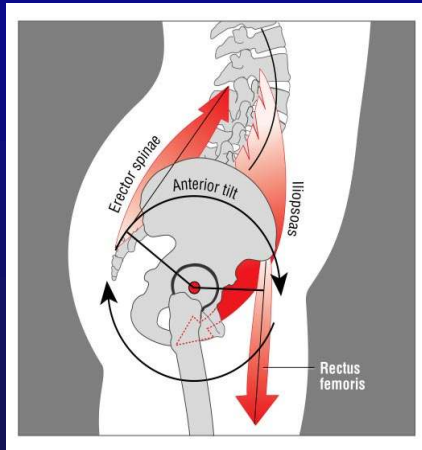
Pelvis Joints Kinematics

- Pelvic girdle moves back & forth within 3 planes for a total of 6 different movements
 - All pelvic girdle rotation results from motion at one or more locations
 - right hip
 - left hip
 - lumbar spine
- Anterior & posterior pelvic rotation
 - sagittal or anteroposterior plane
- Right & left lateral rotation
 - lateral or frontal plane
- Right transverse (clockwise) rotation & left transverse (counterclockwise) rotation
 - horizontal or transverse plane of motion

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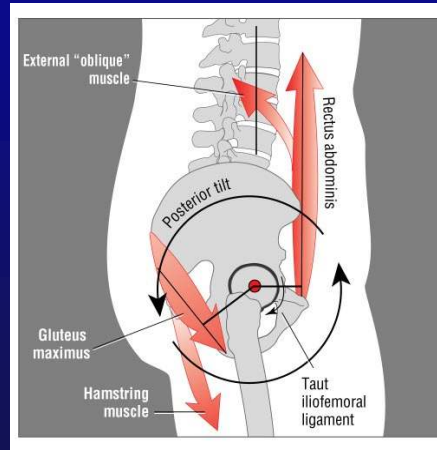
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Pelvic Tilt



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Anterior



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Posterior

Pelvis Movements

- Anterior pelvic rotation
 - anterior movement of upper pelvis; iliac crest tilts forward in a sagittal plane; anterior tilt
- Posterior pelvic rotation
 - posterior movement of upper pelvis; iliac crest tilts backward in a sagittal plane; posterior tilt



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Pelvis Movements

- Left lateral pelvic rotation
 - in frontal plane left pelvis moves inferiorly in relation to right pelvis; either left pelvis rotates downward or right pelvis rotates upward; left lateral tilt
- Right lateral pelvic rotation
 - in frontal plane right pelvis moves inferiorly in relation to left pelvis; either right pelvis rotates downward or left pelvis rotates upward; right lateral tilt



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Pelvis Movements

- Left transverse pelvic rotation
 - in horizontal plane pelvis rotates to body's left; right iliac crest moves anteriorly in relation to left iliac crest, which moves posteriorly
- Right transverse pelvic rotation
 - in horizontal plane pelvis rotates to body's right; left iliac crest moves anteriorly in relation to right iliac crest, which moves posteriorly



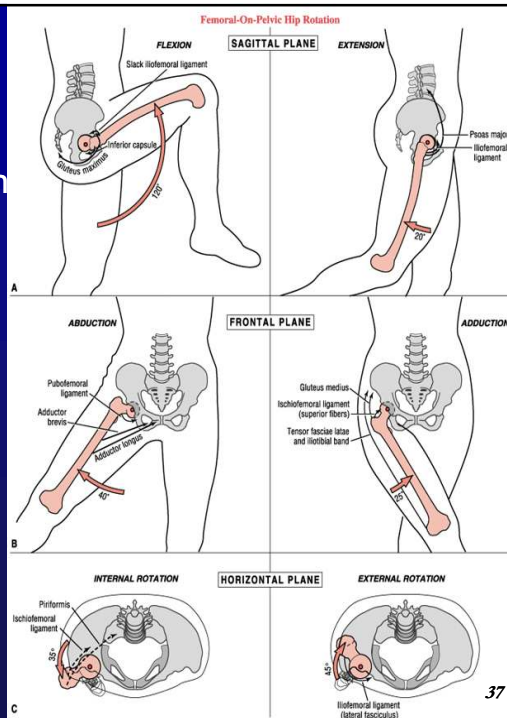
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Femoral on Pelvic Motion

- F on P Motion occurs when hip joint action occurs as a result of the femur moving on a relatively fixed or stationary pelvis
- F on P motion can be closed or open chain movement
 - Closed Chain: i.e. Squat; Stance phase of gait
 - Open Chain: Standing hip extension exercise; Swing phase of gait

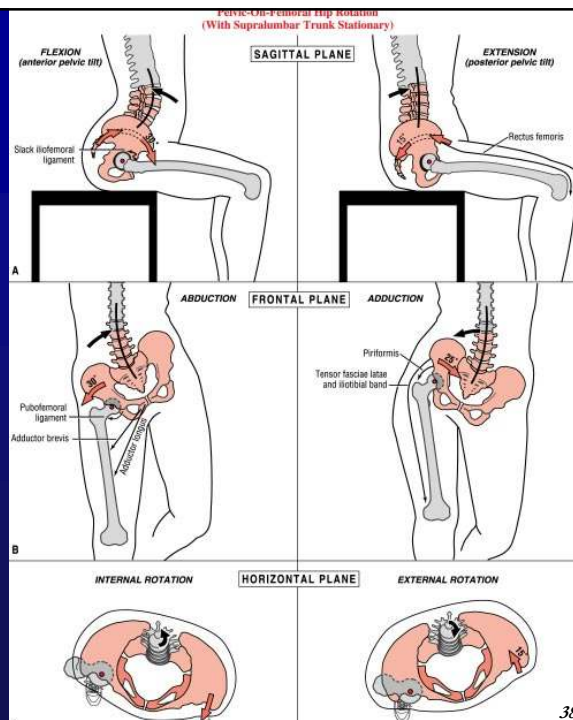
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Pelvic on Femoral Motion

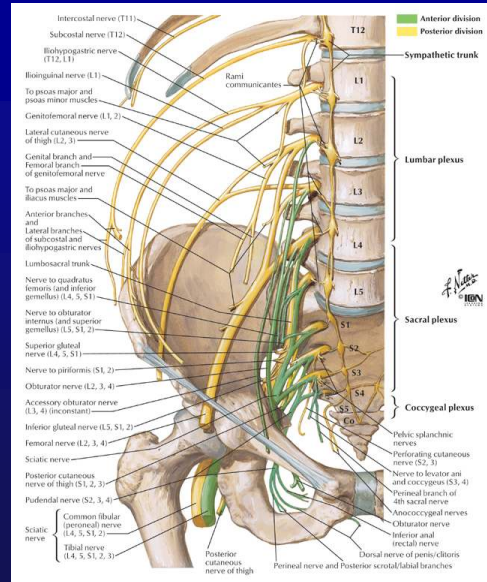
P on F Motion occurs when hip joint action occurs as a result of the pelvis moving on a relatively fixed or stationary femur

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Nerves

- All hip & pelvic girdle muscles - innervated from lumbar & sacral plexus (lumbosacral plexus)

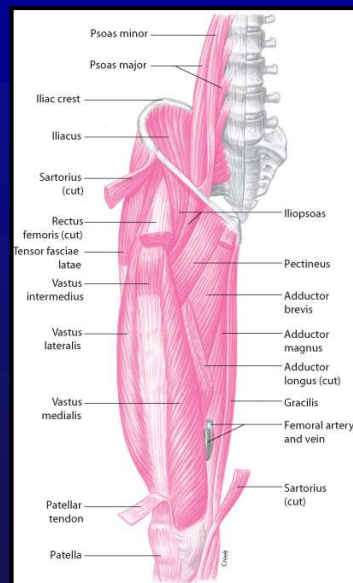


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Hip joint & pelvic girdle muscles

- Anterior - primarily hip flexion
 - Iliopsoas
 - Pectineus
 - Rectus femoris
 - Sartorius
- Medial - primarily hip adduction
 - Adductor brevis
 - Adductor longus
 - Adductor magnus
 - Gracilis

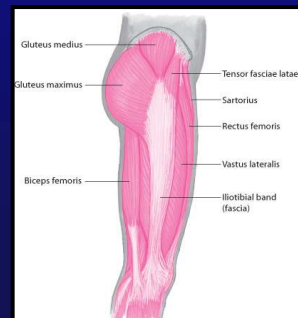
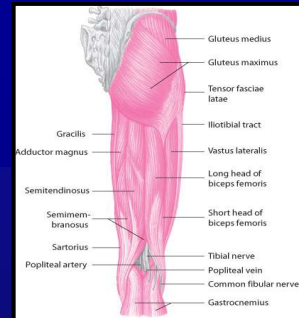


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Muscles (cont.)

- Posterior - primarily hip extension
 - Gluteus maximus
 - Biceps femoris
 - Semitendinosus
 - Semimembranosus
 - External rotators
- Lateral - primarily hip abduction
 - Gluteus medius
 - Gluteus minimus
 - External rotators
 - Tensor fasciae latae

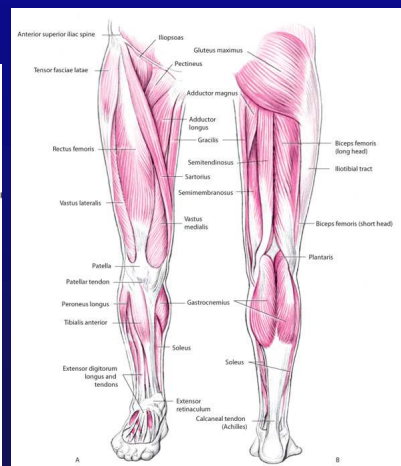
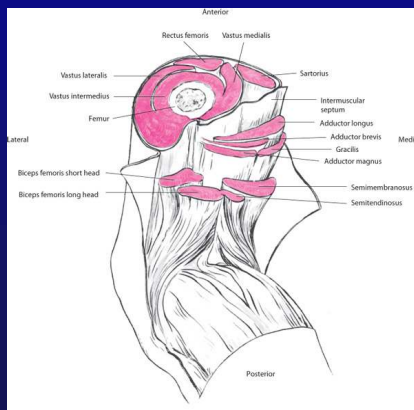


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Muscles (cont.)

- Seven two-joint muscles have one action at hip & another at knee



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Pelvic muscles acting on hip joint

- Iliac region - iliopsoas muscle flexes hip
 - Iliacus
 - Psoas major
 - Psoas minor
- Gluteal region - extend & rotate hip
 - Gluteus maximus
 - Gluteus medius
 - Gluteus minimi
 - Tensor fascia latae
 - Six deep external rotators - piriformis, obturator externus, obturator internus, gemellus superior, gemellus inferior, & quadratus femoris

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Hip Muscle Groups

- Hip Flexors
 - Primary: iliopsoas, rectus femoris, TFL, sartorius, adductor longus, pectineus
- Hip Adductors
 - Primary: Adductor longus, brevis & magnus, pectineus, gracilis
- Hip Internal Rotators
 - Primary: gluteus medius & minimus, TFL

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Hip Muscle Groups (cont.)

- Hip Extensors
 - Primary: gluteus maximus, hamstrings
- Hip Abductors
 - Primary: gluteus medius & minimus, TFL
- Hip External Rotators
 - Primary: gluteus maximus, piriformis, deep external rotator muscles

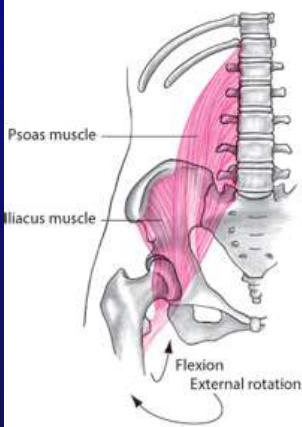
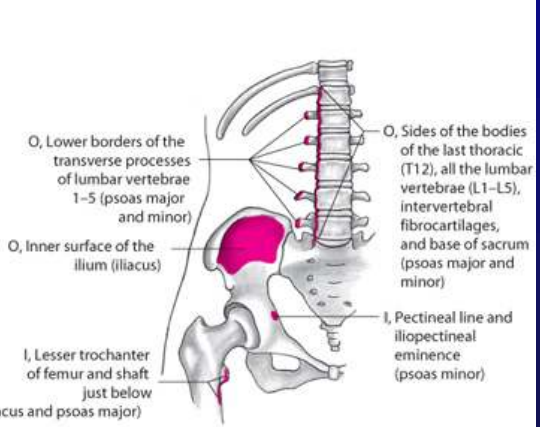
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Iliopsoas Muscle

Flexion of hip

External rotation of femur

Transverse pelvic rotation contralaterally when ipsilateral femur is stabilized

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Sartorius Muscle

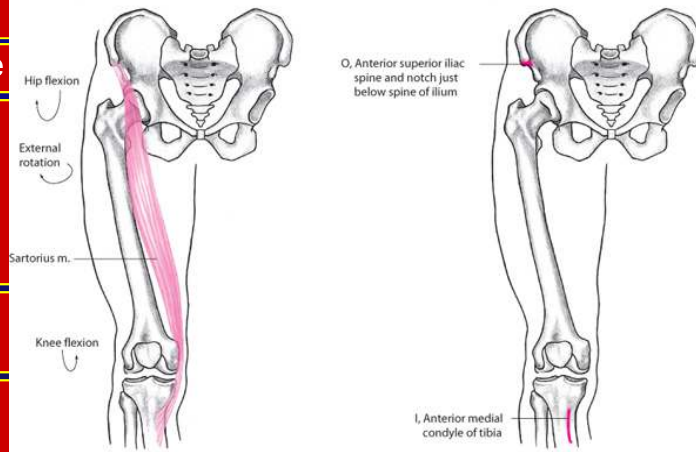
Flexion of hip

Flexion of knee

External
rotation of
thigh as it
flexes hip &
knee

Abduction of
hip

Anterior pelvic
rotation



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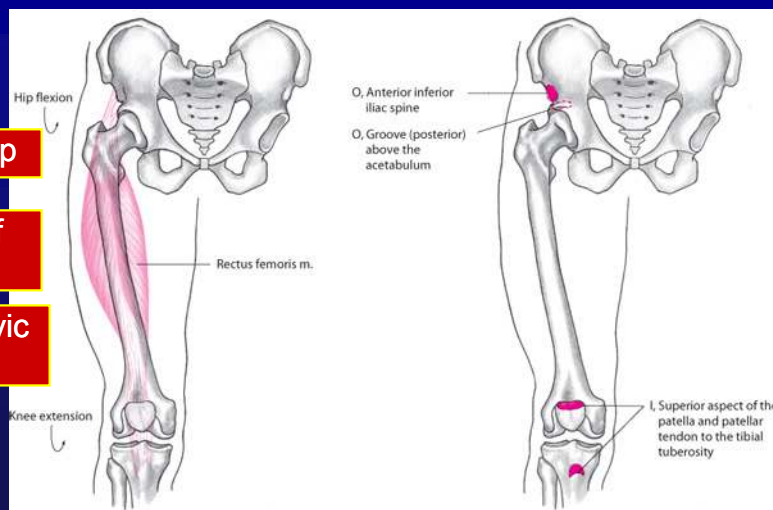
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Rectus Femoris Muscle

Flexion of hip

Extension of
knee

Anterior pelvic
rotation



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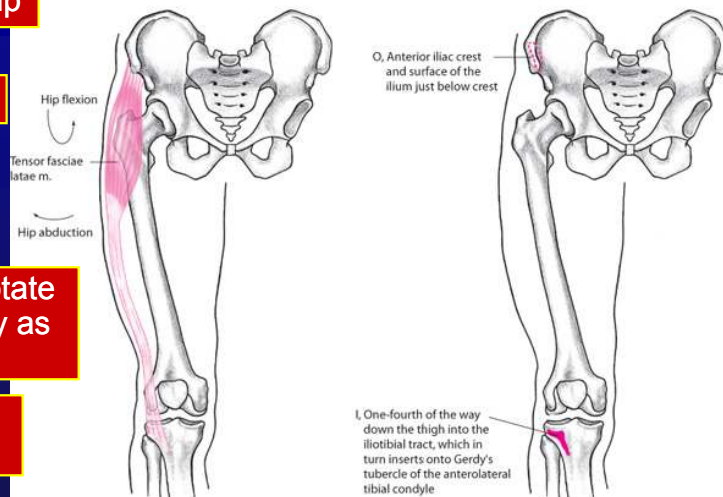
Tensor Fasciae Latae Muscle

Abduction of hip

Flexion of hip

Tendency to rotate
hip internally as
it flexes

Anterior pelvic
rotation



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Gluteus Maximus Muscle

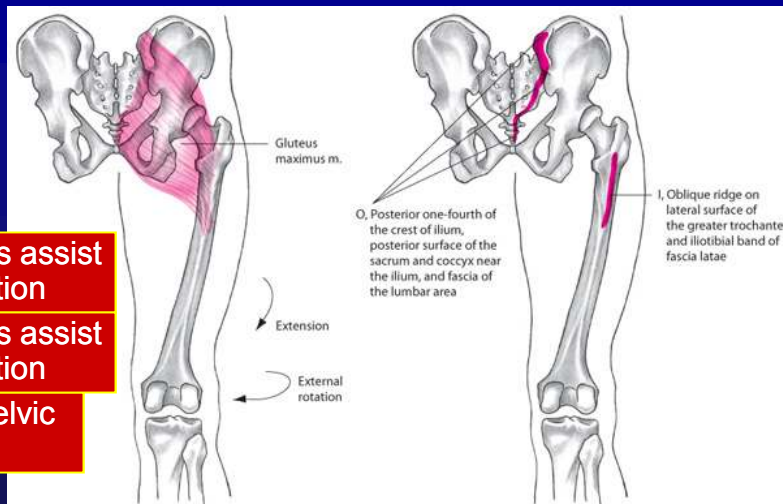
Extension
of hip

External
rotation
of hip

Upper fibers assist
in abduction

Lower fibers assist
in adduction

Posterior pelvic
rotation



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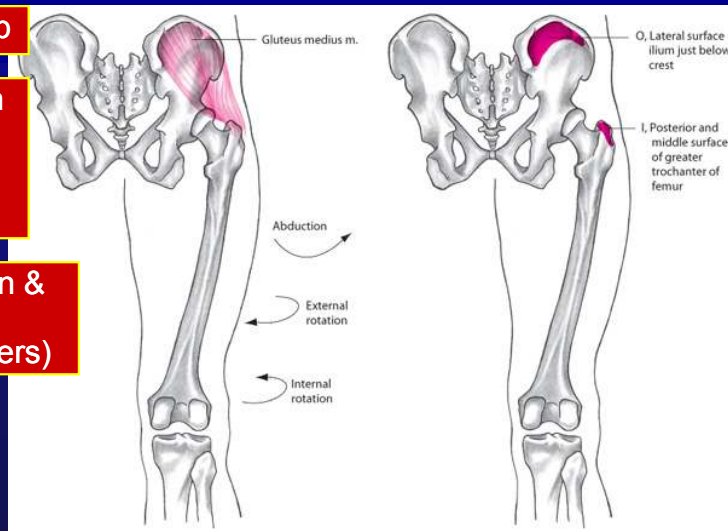
50

Gluteus Medius Muscle

Abduction of hip

Internal rotation
& flexion
(anterior
fibers)

External rotation &
extension
(posterior fibers)



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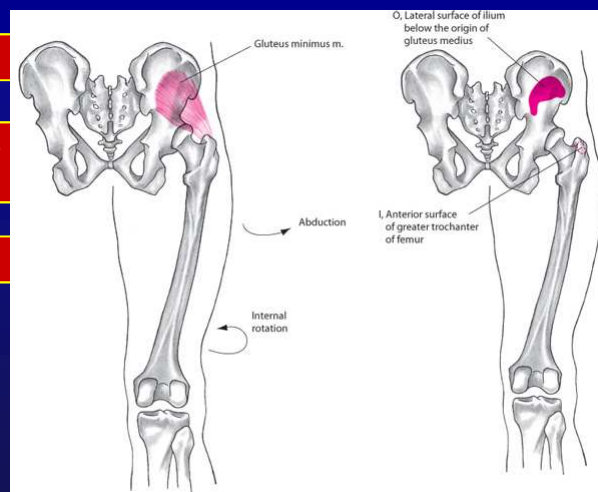
51

Gluteus Minimus Muscle

Abduction of hip

Internal rotation as
femur abducts

Flexion of hip

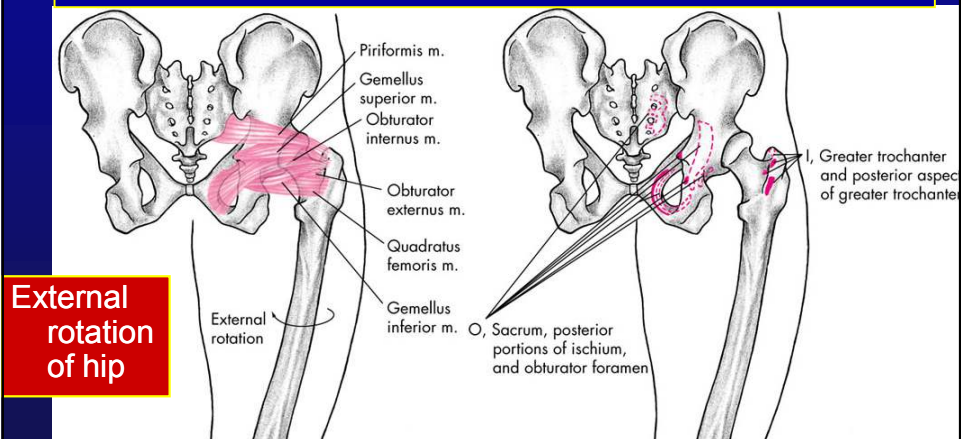


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Six Deep Lateral Rotator Muscles

Piriformis, Gemellus superior, Gemellus inferior, Obturator externus, Obturator internus, Quadratus femoris



External rotation of hip

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Semitendinosus Muscle

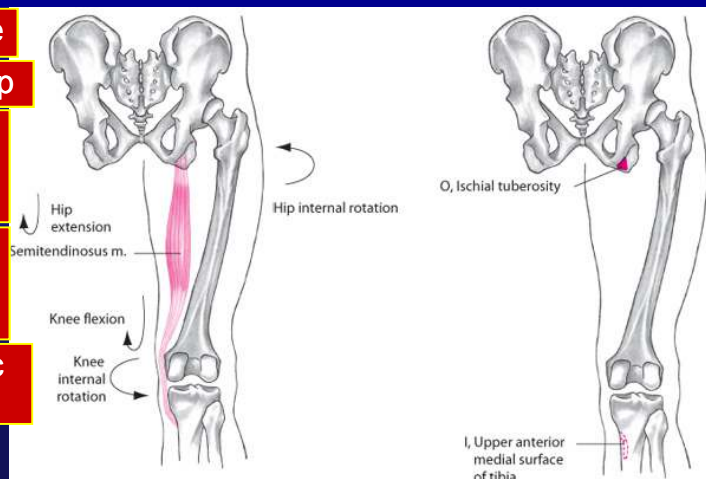
Flexion of knee

Extension of hip

Internal rotation of hip

Internal rotation of flexed knee

Posterior pelvic rotation



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Semimembranosus Muscle

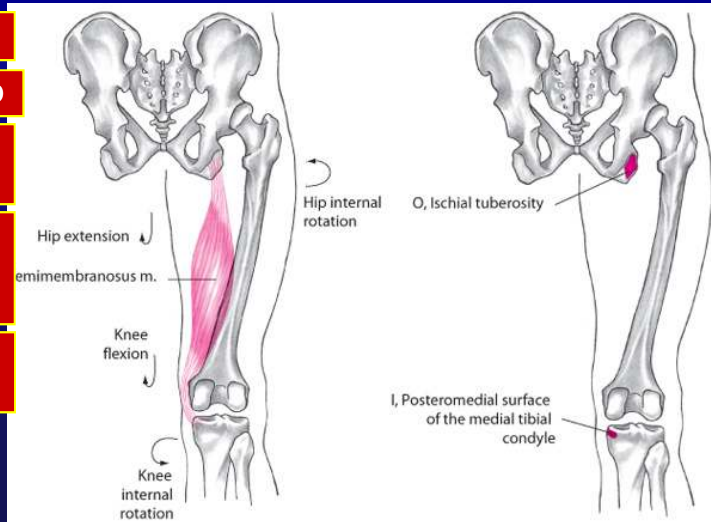
Flexion of knee

Extension of hip

Internal rotation of hip

Internal rotation of flexed knee

Posterior pelvic rotation



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Biceps Femoris Muscle

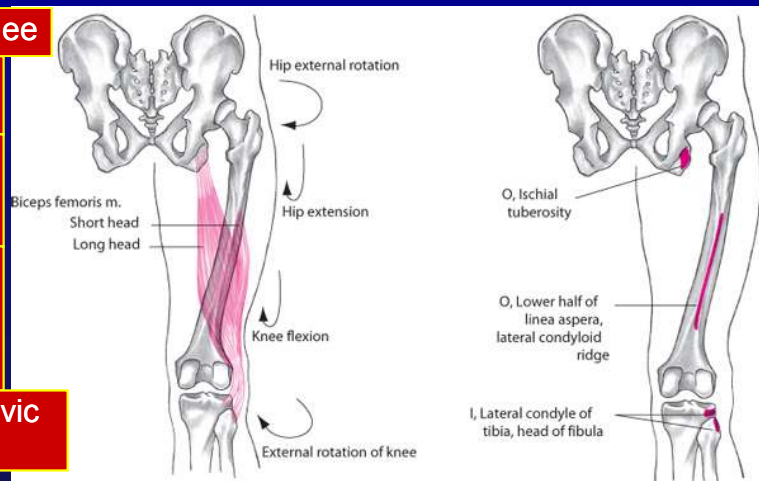
Flexion of knee

Extension of hip

External rotation of hip

External rotation of flexed knee

Posterior pelvic rotation



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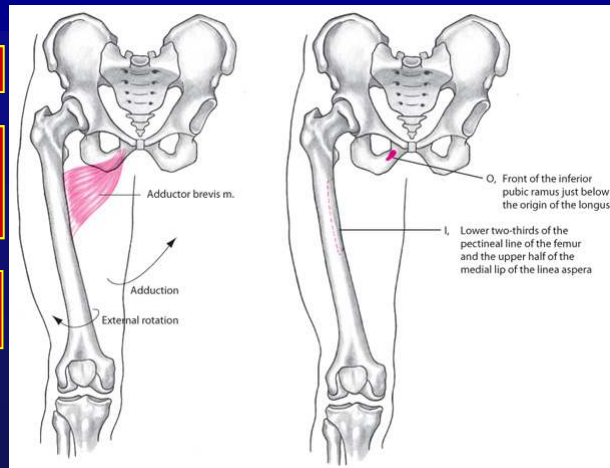
56

Adductor Brevis Muscle

Adduction of hip

External rotation
as it adducts
hip

Assists in flexion
of hip



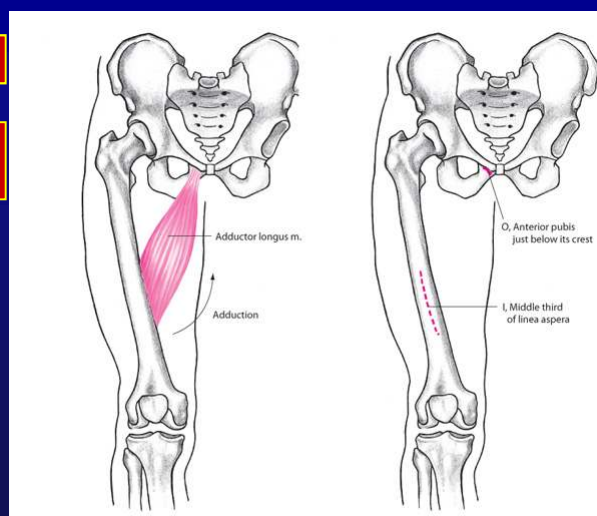
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Adductor Longus Muscle

Adduction of hip

Assists in flexion
of hip



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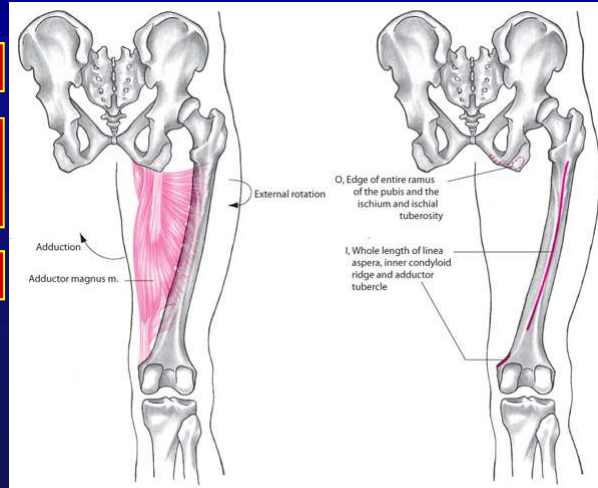
58

Adductor Magnus Muscle

Adduction of hip

External rotation
as hip
adducts

Extension of hip



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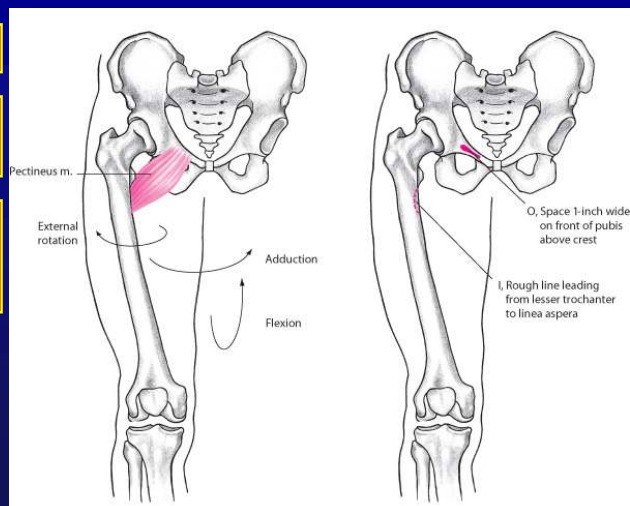
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Pectineus Muscle

Flexion of hip

Adduction of
hip

External
rotation of
hip



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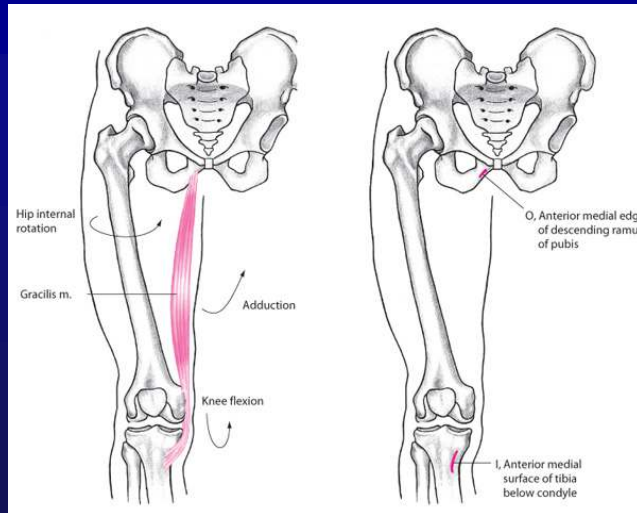
Gracilis Muscle

Adduction of hip

Weak flexion of knee

Internal rotation of hip

Assists with flexion of hip

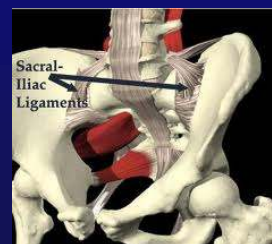
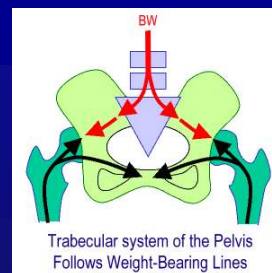


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Factors Affecting Stability of the Pelvis

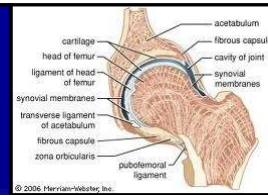
- **Bony configuration:** trabecular system of the pelvis follows the weight-bearing line.
- **Tension of ligaments:**
 - Iliolumbar ligament
 - Sacrospinous ligament
 - Sacrotuberous ligament
 - Sacroiliac ligament: anterior, posterior, & interosseous
- **Dynamic stability of muscles**



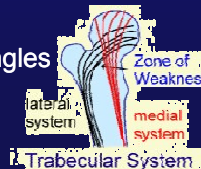
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Trabecular System of the Femur



- **Function:** Accommodate to the mechanical stresses and strains created by the transmission of forces between femur and pelvis
- **classification**
 - **medial trabecular system:** from medial cortex of upper femoral shaft radiating outward to superior cortex of femoral head
 - parallel to joint reaction force on femoral head during single leg stance
 - **lateral trabecular system:** from lateral cortex of upper femoral shaft radiating outward to inferior cortex of the femoral head
 - in response to forces created during hip abductor contraction or to tensile stresses created by gravitational moments of force on femoral head
- **zone of weakness**
 - The area where the trabeculae do not cross at right angles
 - Less reinforcement by trabeculae &
 - More potential for injury



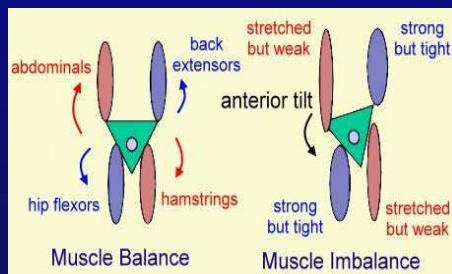
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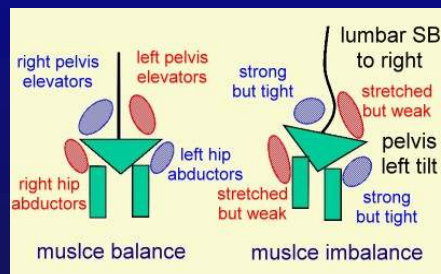
Trabecular System

Factors Affecting Stability of the Pelvis

Sagittal Plane Stability



Frontal Plane Stability



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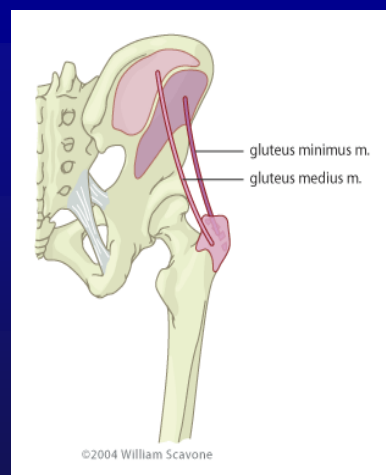
Hip Abductors & Pelvic Stabilization

- Poor pelvic stabilization can occur as a result of functionally weak hip abductor muscles; or as a result of underlying pathology (muscular dystrophy, hip arthritis, hip instability).
- Trendelenburg sign – dropping of the opposite hip and pelvis upon single leg support; indicates poor pelvic stabilization; does not identify cause of instability
- May be compensated for by leaning over the unstable hip

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Trendelenburg Sign



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Stability of the hip joint

- **Bony configuration:** the most important
- **Cartilage:**
 - cartilage at acetabulum thicker peripherally
 - acetabulum labrum deepens the shape of the acetabulum
- **capsular ligaments**
 - longitudinal fibers
 - circular fibers
- **large-size muscles**

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Stability of the hip joint (cont)

- **Tension of ligaments:**
 - **Iliofemoral ligament (Y ligament of Bigelow or Y-ligament):**
 - from anterior inferior iliac spine to intertrochanteric line with 2 slips (medial and lateral).
 - taut in hip hyperextension (both slips) and full external rotation (lateral slip).
 - **Pubofemoral ligaments**
 - from superior pubic ramus and anterior and inferior rim of the acetabulum to blending with medial fasciculus of the iliofemoral ligament
 - taut in hip abduction and hyperextension.

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Stability of the hip joint (cont)

Tension of ligaments (cont):

– Ischiofemoral ligament:

- from posterior and inferior rim of the acetabulum (ischium) to the greater trochanter of the femur.
- taut in hip full internal rotation and hyperextension.

– Ligamentum teres

- no help for the stability of the hip from the fovea of the femoral head to the transverse acetabular ligament of the acetabulum.

– extensive set of capsular ligaments

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Mechanism of Injury at the pelvis

Malalignment

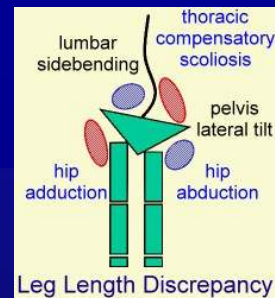
• leg length discrepancy

– long leg side

- Elevated iliac crest
- Sidebending of lumbar spine to the same side
- compensatory scoliosis at thoracic and cervical regions

– short leg side

- Pelvis lateral tilt to the same side
- Sidebending of lumbar spine to the opposite side
- Compensatory scoliosis at thoracic and cervical regions



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Mechanism of Injury at the Hip

- **Direct stress**
 - Femoral neck fracture
 - Intertrochanteric fracture
- **Repeated stresses**
 - Degenerative joint disease (DJD) of the hip
- **Deformities**
 - Congenital dislocation of the hip (CDH) or Developmental dysplasia of the hip (DDH)

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References

Neumann DA (2002). **Kinesiology of the Musculoskeletal System: Foundations for Physical Rehabilitation**. Philadelphia: Mosby. Chapter 9 & 12.

Smith L.K., Weiss E.L., Don Lehmkuhl L. (1996). Brunnstrom's Clinical Kinesiology, 5th ed. Philadelphia: FA Davis. Chapter 8.

Huei Ming Chai

<http://www.pt.ntu.edu.tw/hmchai/kines04/KINlower/Hip.htm>

Functions, stability and joint structure of hip and pelvis; kinematics, muscle action and common injuries of the elbow.

<http://www.joint-pain-expert.net/hip-joint.html>

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